THE

LIFE AND WORK

OF

CHARLES DARWIN;

A Lecture

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BY

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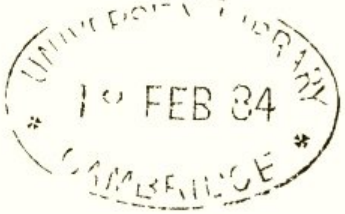

NOTE.

UNTIL the Life of DARWIN by Miss Arabella Buckley shall appear, our information respecting his personal history will probably remain slight and deficient in detail. The "Memorial Notices," reprinted from *Nature;* an article in the *Modern Review*, for July, 1882, by Dr. W. B. Carpenter; and an obituary notice in the Proceedings of the American Academy for 1881–82, are the published accounts which I have found most useful in the preparation of this Sketch.

L. C. M.

CHARLES DARWIN.

THE most notable of CHARLES DARWIN'S ancestors was his grandfather, Dr. Erasmus Darwin,* who was a physician in large practice at Lichfield from 1756 to 1781. Erasmus Darwin was a mechanician, a naturalist, and a poet. He was famed for his inventions: all intended to abridge labour or serve mankind, and most of them practical and valuable. He contrived a horizontal windmill, to grind flints for Wedgwood's pottery; a lamp on the moderator principle; a candlestick which would draw out like a telescope; a manifold writer; a knitting loom; a weighing machine; a flying bird; a canal lock; a rotatory pump; wheels with elastic spokes; and a speaking machine. He proposed a large-wheeled carriage, like that afterwards contrived by Moore, but with many ingenious features of its own. Dr. Darwin was thrown from this carriage in 1768, and limped ever after. He had a speaking-tube put

(*) Most of these particulars are to be found in Krause's "*Erasmus Darwin*," with Preliminary Notice by Charles Darwin. (London, 1879.)

up in his house, to convey messages to the kitchen; and we are told how a countryman waiting below stairs was horrified to hear a sepulchral voice issue from a dying fire and say distinctly, "I want some coals." He was a member, with Priestley, Boulton, Watt, Galton, and Withering, of the famous Lunar Club, which dined together at Birmingham every month, at or near the full moon, for convenience of getting home.

The most curious of his biological speculations are those which turn upon the origin of species. He saw that organisms were not definite, unchangeable creations, but that they reflected the vicissitudes of the earth's surface, besides incorporating in themselves the product of incessant mutual competition.* Not a few passages might be cited as anticipations of the discoveries of his illustrious grandson, such as the notes on mimicry† and insect defences.‡ He regarded a plant not as a mere collection of organs, but as a system of individuals—as the best physiologists of this century also do. An interesting note to the "*Economy of Vegetation*"§ gives an exact and far-seeing view of the function of starch in the economy of plants. Among other anticipations of modern dis-

(*) "*Zoonomia*." Vol. II. Sect. xxxix. 4–8.

(†) "*Economy of Vegetation. Poet. Works.*" Vol. I., note to p. 228; and Vol. II., p. 48.

(‡) Vol. II., pp. 19, 22, 31, 46, 47.

(§) Vol. I., p. 217.

coveries, we find that he was aware of the effect of high temperatures upon animals, causing paralysis of the vessels, and permanent dilatation with fall of temperature. Without having heard of Rosenthal's experiments, he had foreseen not only the result, but the cause of the result.

But Erasmus Darwin was, above all, a utilitarian, and in everything looked for some appreciable and direct good to his fellow-men. He advocated, as Hunter had independently done, the use of bone-dust for manure; sewage was not to be cast into rivers, but spread upon the land; burial-grounds were to be removed from the neighbourhood of houses; every town was to be supplied, not with river-water and surface wells, as was the rule in 1760, but with the purest and softest water, caught in artificial reservoirs, or drawn from artesian wells, as is happily the rule in 1883. Ventilation, wholesome diet, and exercise, he advocated as the cardinal points of physical management. It does not lower our opinion of a man so accomplished, so penetrating, and so deeply interested in the great concerns of mankind, to come now and then upon whimsical conceits. He had, for instance, great faith in the instincts of the child; used to let his children eat and drink what they pleased; and was delighted to see them devour great quantities of fruit and cream. It was comical to his contemporaries, but less re-

markable to us, that he should have regretted that skating, swimming, and dancing on the tight rope "are not allowed to ladies by the fashion of this age and country." Ladies are now accustomed to skate and swim, and they would dance on the tight rope if they cared to.

The poetry of Erasmus Darwin was his great claim to the attention of his contemporaries; but after a fair trial, I am bound to admit that it is no longer readable, except in short lengths. It is stately and vigorous, but the modern reader cannot endure the personification of plants and animals, of elements and diseases, the versificd catalogues, or the introduction of sylphs and gnomes into the Linnean classification.* It is a proof of unusual

(*) I can find space only for one short passage: a description of an electrical machine ("*Econ. of Veg.*" Canto I.) :—

"NYMPHS! your fine hands ethereal floods amass
From the warm cushion. and the whirling glass;
Beard the bright cylinders with golden wire,
And circumfuse the gravitating fire.
Cold from each point cerulean lustres gleam,
Or shoot in air the scintillating stream.
So, borne on brazen talons, watch'd of old
The sleepless dragon o'er his fruits of gold;
Bright beam'd his scales, his eyeballs blazed with ire,
And his wide nostrils breath'd enchanted fire!"

Here is a specimen of the "Loves of the Triangles:"

"Lo! where the chimney's sooty tube ascends,
The fair TROCHAIS from the corner bends!
Her coal-black eyes upturn'd, incessant mark
The eddying smoke, quick flame, and volant spark;

power to have imposed such a yoke upon mankind even for a time. The "*Botanic Garden*" went through several large editions, but was in the end effaced by Canning's "Loves of the Triangles"—an imitation of the "Loves of the Plants," and one of the most effective parodies ever written. We might suspect that the notes and the pictures materially helped out the text, had not the publisher (Johnson) offered Dr. Darwin ten shillings for every verse he should write.

Erasmus Darwin was, further, a freethinker, an admirer of the French Revolution, an early protester against slavery, an opponent of the classical routine in schools. In his own profession he is said to have hated equally the quack and the pedant. Science, industry, and the fine arts filled his mind, and he felt no want of other pursuits or interests. His conversation was plain and blunt,

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Mark with quick ken, where flashing in between
Her much-loved *Smoke-Jack* glimmers through the scene;
Mark how his various parts together tend,
Point to one purpose,—in one object end:
The spiral *grooves* in smooth meanders flow,
Drags the long *chain*, the polish'd axles glow,
While slowly circumvolves the piece of beef below:
The conscious fire with bickering radiance burns,
Eyes the rich joint, and roasts it as it turns.
So youthful Horner rolled the roguish eye,
Cull'd the dark plum from out his Christmas pye,
And cried in self-applause—How good a boy am I!"

The passage imitated is one on cotton-spinning ("Loves of the Plants," Canto II.)

often satirical; he was indifferent to the opinion of all but intimate friends, and often shocked even them by rough words or crude theories.

Erasmus Darwin had six sons, none of whom attained fame. A daughter, Violetta, married Mr. Galton, and in her descendants some of the memorable qualities of her father have reappeared. The third son, Robert Waring Darwin, was a physician at Shrewsbury, 1766–1849. He married a daughter of Josiah Wedgwood, and two families of uncommon qualities are thus represented in his posterity. R. W. Darwin was unlike his father, and nearly all his brothers, in having no turn for poetry or mathematics. We are told on the highest possible authority that he had not a scientific mind, but he was famed in his own district for an almost infallible diagnosis, which surely implies some of the qualities of a scientific discoverer. Mr. Mozley, in his "*Reminiscences*," says of him:—"He was, I think, the biggest man I ever saw out of a show. . . . When he entered a room it was like the door coming upon you broadside on. But what most struck me was the small, soft voice that proceeded from this mountain." *

Charles Darwin was born at Shrewsbury, February 12th, 1809. He was educated at Shrewsbury Grammar School, of which Dr. Butler, afterwards Bishop of Lichfield, was then head-master. The

(*) Vol. II., p. 412.

accounts of his boyhood are very meagre. One of his schoolfellows says that he was cheerful, good-tempered, and communicative; always occupied in leisure hours with botany. In 1825, being then sixteen, he went to Edinburgh, of which University his father and grandfather were both graduates in medicine. In Edinburgh it appeared that he had no vocation for medicine, and it was thought that the Church might suit him better. Accordingly, after two years, he removed to Cambridge, where he took an ordinary B.A. degree in 1831. The great event of his Cambridge life was his coming under the influence of the late Professor Henslow, who had just exchanged the professorship of Mineralogy for that of Botany. Henslow was greater as an inspirer of others than as an investigator. He did a small amount of respectable work in Geology and Botany, but he will be remembered by his pupils, by his charming Elementary Lessons in Botany, and by the care and skill with which he trained the village children of Mitcham. Mr. Darwin wrote of Henslow: "Nothing could be more simple, cordial and unpretending, than the encouragement which he afforded to all young naturalists. I soon became intimate with him, for he had a remarkable power of making the young feel comfortably at ease with him, though we were all awe-struck with the amount of his knowledge.

Before I saw him, I heard one young man sum up his attainments by simply saying that he knew everything. . . . He would receive with interest the most trifling observation in any branch of Natural History, and however absurd a blunder one might make, he pointed it out so clearly and kindly, that one left him in no way disheartened, but only determined to be more accurate another time. . . . Reflecting over his character with gratitude and reverence, his moral attributes rise, as they should do in the highest characters, in pre-eminence over his intellect."

Charles Darwin's gratitude to Henslow was life-long. He used to say that before he knew Professor Henslow he cared for nothing in nature but foxes and partridges.* Henslow made him an entomologist and botanist, a mineralogist and geologist, set up in his mind a standard of thoroughness in all his work, and appointed to him his first task.

It was on a field excursion at Cambridge that Henslow told Darwin that he was commissioned to recommend a young naturalist to accompany Captain Fitzroy on the surveying voyage of the Beagle. Darwin caught at the offer, gained with

(*) This is not to be taken too literally. Darwin had been, like Sir Roderick Murchison, a keen fox-hunter, but he had never been that alone. As early as 1826, while an Edinburgh student, he wrote two Natural History papers (one of them on the ova of Flustra).

some difficulty the consent of his father, who thought it would "unsettle him for the Church," and started on a five years' voyage in December, 1831. He volunteered his services, without salary, but stipulated that he should have the disposal of his own collections.

It was a little more than fifty years ago. The events of those years are still memorable. In 1830 the Revolution of July had ended the old monarchy of France; the great controversy between Cuvier and St. Hilaire, upon the permanence of species and the unity of type in the animal kingdom, had closed in victory for the traditional views; Lyell's "*Principles of Geology*," in so many respects the preparer of the way for Darwin, had appeared. 1831 was the date of "*Sartor Resartus*;" 1832 of the death of Goethe, and of the English Reform Bill. We shall hardly find any time since 1789 more fruitful of lasting consequences than these three, 1830–2; and not the least among these significant events was the beginning of Darwin's scientific career.

The survey of Patagonia, Tierra del Fuego, and part of the Pacific coast, was the primary object of the voyage; but for us, the opportunities afforded thereby to the young naturalist are of far greater interest than any geographical results. The ship crossed the Atlantic to Brazil. Here Darwin made his first acquaintance with tropical scenery. At

Punta Alta, on the Rio Plata, he disinterred numerous gigantic quadrupeds of late tertiary ages—the Megatherium, Megalonyx, Scelidotherium, Mylodon, Macrauchenia, and Toxodon. These fossils, afterwards described, some of them for the first time, by Professor Owen, not only added some striking types to the registers of extinct animals, but set Darwin thinking upon the relations of the species now inhabiting the great continents to their immediate predecessors. "The wonderful relationship," he says, "in the same continent, between the dead and the living, will, I do not doubt, hereafter throw more light on the appearance of organic beings on our earth, and their disappearance from it, than any other class of facts." The "*Origin of Species*" shews that this subject lay long in his mind, and yielded results twenty-seven years later. The Pampas had much to tell him, not only of curious plants and animals—of a new species of ostrich, of viscachas and burrowing owls; of the burrowing tucutucu, which, as Lamarck would have said, was passing into the complete blindness of the Asphalax and Proteus; of the Trigonocephalus, with its hard-pointed tail, a simpler kind of rattlesnake—but also of changes of level, of natural barriers to the range of species, and of the mode in which the West Indies and South America had come to form distinct natural history provinces. Patagonia gave him

examples of denudation on the great scale, and forced upon his attention the changes recently brought upon the animal life of the American continent. Tierra del Fuego is, I believe, to all readers the most fascinating part of the voyage. The account of the wretched inhabitants is at once vivid and pathetic. Darwin says:—"The astonishment which I felt on first seeing a party of Fuegians on a wild and broken shore will never be forgotten by me, for the reflection at once rushed into my mind—such were our ancestors. These men were absolutely naked, and bedaubed with paint; their long hair was tangled, their mouths frothed with excitement, and their expression was wild, startled, and distrustful. They possessed hardly any arts, and, like wild animals, lived on what they could catch. They had no government, and were merciless to every one not of their own small tribe."* The naturalist and geologist will find even greater interest in the account of the climate and productions of Tierra del Fuego, and the comparison, point by point, with Western Europe.

Then the *Beagle* sailed into the Pacific, and the Andes appear as the next scene in this fine panorama. Earthquakes and their traces, elevation and subsidence of the land, the absence of denuding power in deep water, contrasts of vegeta-

(*) "*Descent of Man.*" Chap. xxi.

tion and animal life on the two sides of the great mountain chain, silicified trees, the ancient civilisation of the Incas—these and a hundred other topics come up for description. Then we reach the Galapagos archipelago, whose animals, and especially the birds of which, suggested that striking chapter of the "*Origin of Species*" on "the Relations of the Inhabitants of Islands to those of the nearest Mainland." Why, on these tiny islets, differing in geological character from the American continent, and placed under a peculiar climate, should the type of organisation be American? Why should the different islands, within sight of each other, formed of the same rocks, with precisely similar climate, and rising to a nearly equal height, be inhabited by different forms? "Here," he notes in his Journal (prophetically—for he did not as yet fully realise his own words), "we seem to be brought somewhat near to that fact—that mystery of mysteries—the first appearance of new beings on this earth." Tahiti and New South Wales come next, and lastly the Coral Islands. Darwin's account gives us first the general appearance of an atoll; then a minute account of its flora and fauna; then a detailed history of the growth of coral, of the conversion of fringing reefs into barrier reefs, and of these into atolls. This conversion is shown to imply a slow subsidence, vast in amount and extent, and finally the new theory of coral reefs is

completed by the ingenious and telling argument drawn from the distribution of volcanoes in the Southern hemisphere.

Perhaps no voyage could have been planned to bring in so many phenomena, suggestive and useful to one who was destined to life-long work in natural science; certainly no voyage has ever yielded such results.

Darwin himself sums up the pains and pleasures, the advantages and disadvantages of a voyage round the world, in a very interesting concluding chapter. On the whole (he says) the pleasures at the time do not counterbalance the evils, and the traveller must be sustained by the hopes of good to come. The boasted glories of the ocean subside into a tedious waste, a desert of waters. No doubt there are some delightful scenes. A moonlight night, with the clear heavens and the dark glittering sea, and the white sails filled by the soft air of a gentle trade-wind; a dead calm, with the heaving surface polished like a mirror. It is well once to behold a squall with its rising arch and coming fury, or the heavy gale and mountainous waves. The pleasures of new scenery are a constant source of enjoyment. Yet he thinks it probable, that the picturesque beauty of many parts of Europe exceeds anything which he beheld, except in the intertropical zones. "Among the scenes which are deeply

impressed on my mind, none exceed in sublimity the primæval forests, undefaced by the hand of man; whether those of Brazil, where the powers of life are predominant, or those of Tierra del Fuego, where death and decay prevail." His memory runs also upon the boundless plains of Patagonia, the scene from the highest crest of the Cordillera, the first sight of a savage in his native haunt, the Southern Cross, the cloud of Magellan, a water-spout, a glacier overhanging the sea, a coral island, an active volcano, and an earthquake. To the voyager, the map of the world ceases to be a blank; it becomes a picture full of varied and animated figures.

Thus trained and thus inspired, with his mind full of new facts, his imagination full of vivid scenes, the young naturalist returned home to describe what he had seen; to compare his experiences with those of other travellers, and with one another. He was destined to raise a great structure upon these foundations.

One consequence of the five years' cruise is only twice, and very slightly, mentioned in his Journal. During the voyage he suffered incessantly from sea-sickness. This seems to have brought on the dyspepsia, which clouded the whole remainder of his life. We may justly admire the fortitude with which a volunteer, a man of fortune, with continual opportunities of

return, faced this dispiriting enemy for five years, coming home with his companions when the voyage was done. His only remark was: "If a person suffer much from sea-sickness, let him weigh it heavily in the balance. I speak from experience: it is no trifling evil." Many years after, in his beautiful memoir on Climbing Plants, he mentions a potted plant, kept day and night in a well-warmed room to which he was confined by illness. Few readers could suspect that this, like many other laborious inquiries, had been carried on with almost daily interruption from a depressing disease. In fact, he counted as good days those in which he could give as much as two hours to work; and, for the greater part of his life, these were outnumbered by the days on which he could not work at all. In his later years there was a marked improvement, and after about 1860, he was able to work with fewer interruptions.

For ten years (1836–46) Darwin's chief work was the elaboration of his results. The Lords of the Treasury granted £1,000 for the purpose, to which Smith & Elder, the publishers, and Darwin himself, added further sums of money. The outcome was, first, the "*Zoology of the Beagle*," in five quarto volumes. Professor Owen described the Fossil Mammalia, which were the most interesting part of the collections; while Waterhouse, Gould,

Bell, and Jenyns undertook other divisions. The plants were published in various places by Hooker, Henslow, and other botanists; and a number of memoirs of less consequence were founded upon the invertebrate collections. Darwin himself wrote three separate volumes on special subjects, viz.:—(1) On Coral Reefs (1842); (2) On Volcanic Islands (1844); (3) On the Geology of South America (1846); besides three papers in the Transactions and Journals of the Geological Society. In 1845 he published a Journal of Researches, which, in a shorter and more popular form (*"Naturalist's Voyage Round the World"*) has been very widely read.

In 1839, Charles Darwin married his cousin, Emma Wedgwood, and in 1842 settled at Down, near Bromley, in a plain but comfortable brick house, standing in a few acres of pleasure-ground, old-fashioned, and endowed, as we are told, "with a sense of peace and silence." Here he lived for forty years, a man of easy fortune, and but for ill-health, possessed of every advantage which the world can offer. He did not mix at all in society, and was rarely seen even at scientific meetings; but it was his constant delight to be surrounded by friends in his own house. From 1838 to 1841 he was Secretary to the Geological Society, and during this section of his life he seemed to look upon geological research as his main business. He gave

other men the zoological and botanical results of his voyage to work out, reserving the geology for himself; and his memoir on Coral Reefs, which belongs to natural history at least as much as to geology, was published as part of the "*Geology of the Beagle.*"

The *Beagle* was finally disposed of in 1846, and the next great piece of work which Darwin undertook brought him back to Zoology. This was the memoir on the Cirripedia, published by the Ray Society, in two volumes of more than a thousand pages and forty plates, in 1851 and 1854. We pass over this memoir, whose interest is, but for one striking discovery, hardly to be communicated to any but comparative anatomists, merely remarking that it is a masterly piece of technical work. In after years, his opponents were never weary of praising it; and of wishing, as they well might wish, that he would keep to Comparative Anatomy. Mr. Romanes, on the contrary, has our sympathy when he says: "We cannot be sorry that he engaged upon and completed this solid piece of morphological work, because it now stands as a monument to his great ability in this direction of inquiry; but, at the same time, we feel sincerely glad that the conspicuous success which attended the exercise of such ability in this instance, did not betray him into other undertakings of the same kind.

Such undertakings may suitably be left to establish the fame of great though lesser men: it would have been a calamity in the history of our race if Charles Darwin had been tempted by his own ability to become a comparative anatomist."

We now come to the "*Origin of Species*," the great centre of Darwin's scientific work. Suggested by the voyage of the *Beagle*, and long meditated, it was not publicly mentioned till 1858, and only a happy accident forced on its publication so early as 1859. Perhaps no achievement of the human intellect has more completely realised the ideal of man's life-mark—"*Une pensée de jeunesse exécutée par l'âge mûr.*" I compile, from two separate statements by Darwin himself, the following account of the preparation of this work:—*

"In South America, three classes of facts were brought strongly before my mind. Firstly, the manner in which closely allied species replace species in going southward. Secondly, the close affinity of the species inhabiting the islands near South America to those proper to the continent. This struck me profoundly, especially the difference of the species in the adjoining islets in the Galapagos archipelago. Thirdly, the relation of the living Edentata and Rodentia to the extinct species. I shall never forget my astonishment when I dug out a gigantic piece of armour like

(*) *Haeckel, Schopfungsgeschichte; Introduction to "Origin of Species."*

that of the living armadillo. Reflecting on these facts, and collecting analogous ones, it seemed to me probable that allied species were descended from a common parent. But, for some years, I could not conceive how each form became so excellently adapted to its habits of life. I then began systematically to study domestic productions; and, after a time, saw clearly that man's selective power was the most important agent. I was prepared, from having studied the habits of animals, to appreciate the struggle for existence; and my work in geology gave me some idea of the lapse of past time. Therefore, when I happened to read '*Malthus on Population*,' the idea of natural selection flashed on me. . . . After five years' work, I allowed myself to speculate on the subject, and drew up some short notes; these I enlarged, in 1844, into a sketch of the conclusions which then seemed to me probable; from that period to the present day (1859) I have steadily pursued the same object. . . . Mr. Wallace, who is now studying the natural history of the Malay archipelago, has arrived at almost exactly the same general conclusion that I have on the origin of species. In 1858 he sent me a memoir on this subject, with a request that I would forward it to Sir Charles Lyell, who sent it to the Linnean Society. Sir Charles Lyell and Dr. Hooker, who both knew of my work—the

latter having read my sketch of 1844—honoured me by thinking it advisable to publish, with Mr. Wallace's excellent memoir, some brief extracts from my MSS."

I shall attempt no abstract of the "*Origin of Species*." It is itself highly condensed—a sort of intellectual pemmican, Huxley called it—a mass of facts crushed into shape. Besides, difficult as the book undoubtedly is, it is a classic. No one who has any opinion at all as to the course of life upon the earth, can excuse himself from mastering it.

If I do not justify the Darwinian theory of evolution, or even state it, it would seem hardly fair to criticise it. Moreover, my own opinion is of microscopically small importance. Nevertheless, I hope to be pardoned if I offer a short statement of the views which I have been led to adopt.

The evidence for the theory of descent with modification may be roughly divided into that drawn from Zoology and Botany, from Embryology, from Distribution, and from Palæontology. I cannot hope in a few sentences to point out the many ways in which the Darwinian theory, applied to the problems of the zoologist or botanist, has at once elucidated them and verified itself. One instance must suffice. For half a century naturalists had been puzzling over a mysterious quality which they called "affinity." They saw, as no

trained eye can help seeing, that there are in nature strongly marked groups, such as bats or birds among animals, ferns and conifers among plants. What is the tie which unites the forms composing each group? Perhaps you answer, "Resemblance." Yet, you find that while the zoologist rejects with contempt any proposal to unite, in one order, animals so like in outward form and mode of life as mice and shrews, or porpoises, seals and sharks, he finds tolerably close "affinity" between creatures so unlike as a seal and a dog, and has no scruples about placing them in the same order. The botanists are unanimous that an elm and an oak are only related as belonging to the very wide division of dicotyledonous flowering plants, but they find near "affinity" between the elm and the nettle. The naturalists, till Darwin appeared, were as much at fault as anybody else, and could give no intelligible account of a relation which they named and applied so often. Lindley, in 1853, tried to cut the knot by declaring that "affinity" was simply correspondence in structure, and that the relative value of natural history characters depended upon their physiological importance. Others have repeated the same words as if they were obviously and necessarily true, but these principles will not work in practice. Among ordinary plants, by far the most important organs

are the organs of assimilation—the leaves. The whole nutrition, except in the case of parasitic plants, depends upon them; and in the leaves the green chlorophyll-corpuscles are the active elements. Suppose we arranged a primary division according to the presence or absence of chlorophyll-corpuscles, and went on subdividing by the extent and form of the leaves. Lindley would have shaken his head at such a classification, and, I hope, modified his definition of affinity. Or suppose that you tried to arrange your animals by the nervous system, the organs of circulation, or the organs of respiration. Fritz Muller* has actually tried these characters, for the sake of argument, upon the class of Crustacea; others, in all good faith and hopefulness, have tried them upon Vertebrates, Mammals, and various Invertebrate groups. But it will not do. The groups so formed violate the naturalist's sense of affinity; and he trusts his sense of affinity rather than his definitions or theories.

Well, this tangle was at last simplified. On Darwin's principles, "affinity" between plants and animals means just what it does among ourselves—blood-relationship. The classes and orders of the animal kingdom have had a history, a common descent; they have become defined by the extinction of connecting links; they are facts of nature

(*) "*Facts for Darwin*," p. 107.

in nearly the same sense as clans and families of mankind. The new definition has been tried—is being daily tried—upon the classification of plants and animals, and it has not been found wanting.

The evidence from Embryology is even more cogent. The circuitous path by which all the higher animals attain their adult organisation, the almost or altogether purposeless and transitory organs which they so often exhibit, the community of structure shewn by animals which subsequently become extremely unlike—these and many similar considerations forbid the student of development to suppose that the life-history of the higher animals can have been always what it now is; every embryologist is accordingly a Darwinian.

So, too, with the facts of Geographical Distribution. They lose their meaning at once if you disconnect them from the changing history, not only of the earth's surface, but also of the animal life which occupies it; and now that Wallace has given us an explanation, so well-connected and so luminous, it is impossible to go back to the old view that adaptation to soil or climate is the great factor in defining the range of species.

Now we pass to Palæontology, and it might be expected that the direct appeal to history would bear out the conclusions of Embryology and Dis-

tribution. The answer of Palæontology, on the contrary, is conflicting and uncertain. It does indeed tell of divergence here and there, of types branching out into several well-marked forms; of modification advancing regularly with the lapse of time, but it tells us also of the immense antiquity of the leading types. Go back as far as you can into the history of the earth, you have still your Molluscs, your Crustacea, your Echinodermata. More than this, in the oldest fossiliferous system (the Silurian) we find not only Mollusca, but the existing classes of Mollusca, some of the existing orders and families; a few even of the existing genera (Nautilus, Chiton, Pleurotomaria, Lingula). In other words, in the earliest fossil-bearing rocks, we find the Animal Kingdom differentiated to its present extent, as nearly as we can tell; and many of those early forms are practically the same as others which inhabit modern seas. There seems no possibility of running up the various strands of the Animal Kingdom into one or even into twenty primordial forms, unless we assume that the time from the Silurian period to the present is as nothing compared with the previous lapse of terrestrial history. We seem driven to imagine, if Sir William Thomson will allow us, an infinity of pre-Silurian time, during which the earth and its inhabitants were subject to existing conditions—a vast creation of which the very ruins

have perished. Palæontology shows us here and there Natural Selection at work; it nowhere absolutely compels us to limit the sphere of its operation; but it does not tell us upon what Natural Selection first began to work; it tells us nothing of the origin of the Animal Kingdom. On this point we are left almost as much in the dark as if we had only the existing species to compare. This, like every other difficulty of real weight, has been taken into account by Darwin. In the ninth chapter of the "*Origin of Species*" he discusses it at length, and dismisses it as inexplicable, admitting that it may fairly be urged as a valid argument against his views. The Darwinian has to make much of the imperfections of the geological record, in order to avoid the inference that the divergence of animal forms has seldom extended to classes; seldom, indeed, to orders. I am willing to concede all that is asked on this head; but I cannot as yet find in Palæontology the proof, and, indeed, hardly the possibility, that all animal life has had a common origin.

Here, then, we seem to find a contradiction between the conclusions suggested by Embryology, for instance, and by the history of life upon the earth. I think it may be useful to mark and even to emphasise the contradiction, in the hope that we may the more speedily resolve it.

It is, perhaps, hardly wise to go back so far into

the history of scientific speculation as the memorable controversy of 1830; and yet that controversy has much to do with the temper in which the scientific world received the "*Origin of Species.*" Let me remind you of the still older Lamarckian Theory of Descent,—transformation of species by means of changed habits, use and disuse of organs, and the like. Geoffroy St. Hilaire the elder held with Lamarck in all this, but attached much more importance to the "*milieu ambiant,*" the continual change of conditions, not in the organism and its activities, but in the surrounding medium. St. Hilaire thought that in old times the atmosphere was richer in carbonic acid than now, and that the change to the existing proportion had, among other effects, brought about the development of birds from lizards. The respiratory process became more energetic, the temperature of the blood rose, the sluggish reptile was stimulated to fly, and the scales became gradually transformed to feathers. He thought, too, that over-much attention had been paid to teleological explanations. The bones of the wing, of the fin, and of the arm are, it is true, adapted respectively to flight, swimming, and prehension; but, according to St. Hilaire, they became so adapted, not by design, not in order that the animal which possesses them may fly, swim, or seize, but because a common organic type had been exposed to diverse conditions. The

wing, fin, and arm are the products of two factors—(1) a common law of organisation (*unité de composition*); (2) a difference in the ambient medium. It was necessary to his views to regard the whole animal creation as of one kindred; and St. Hilaire in the most explicit manner affirmed that all the species now living are descended by uninterrupted succession from the extinct species of geological time. St. Hilaire and his partisans were keen, zealous, enthusiastic men, of that quality of mind which is not easily shocked by absurdities or easily borne down by authority.

The fortune of the contest provided for them an antagonist of crushing weight. Cuvier was, in intellectual power, one of the giants of the human race; a man of vast energy and industry, never idle and never hurried, clear in every thought and purpose and word. He saw facts clearly, stated them clearly, reasoned from them clearly. It is to the anatomist of to-day a delight to read any one of his thousand memoirs. The transparent style, the beauty of arrangement, and more than all, the way in which the facts seem to wait upon him—novel and yet undeniable facts springing forth to abolish doubt: it seems like a great literary artifice, yet it stands to-day as firm, in all matters of fact at least, as it stood sixty years ago. Then, to make him yet more formidable as an adversary, Cuvier had been en-

dowed with a character like that of other men;—he was worldly and ambitious, he could strike home without remorse; he could deliberately sharpen his weapons. Strong in his command of facts, Cuvier had no misgiving as to his interpretations; he had little power of making allowance, no prophetic gift, no dim sense of remote possibilities. St. Hilaire he beat by greater knowledge, by better management of his case, and also, it must be admitted, by his personal influence over secret committees.

The spiteful element in our nature is gratified at times when we read Cuvier's replies to his opponents. You can imagine what grave fun he makes of the ambient medium, of the identification of the squamosal bone with a supposed humerus of the head; of the comparison of a mollusk to a vertebrate bent double; how he calls for proofs just of those propositions which the other side had taken for granted; how he meets animated, and sometimes angry, outbreaks with a cool civility, in which there is something deadly. One turn of the conflict has been remembered down to our own times by men who are not in general students of biological questions. To all claims of gradual transformation still in progress, he replied by various proofs drawn from his own immense magazine, of mummies and other buried remains, in which, after thousands of years, the

smallest details are found to agree exactly with the species of the present day. When there was talk of gradual metamorphosis in times long past, he called for evidence of the connecting links, and demolished every supposed case with the ease of an expert to whom all palæontology was known ground—ground indeed, much of which he had been the first to explore.

The attention of scientific men in every part of Europe was fixed on the controversy. Soret gives us some notion of the excitement of Goethe, then an old man, strongly persuaded of the derivation of one species from another, and himself a figure in the history of the doctrine of evolution.

"*Monday, August 2nd*, 1830. The news of the outbreak "of the Revolution of July arrived in Weimar to-day, and "has caused general excitement. In the course of the "afternoon I went to Goethe. 'Well!' he exclaimed, as I "entered 'what do you think of this great event? The "volcano has burst forth, all is in flames, and there are no "more negotiations behind closed doors.' 'A dreadful affair,' "I answered; 'but what else could be expected under the "circumstances, and with such a Ministry, except that it "would end in the expulsion of the Royal Family?' 'We "do not seem to understand each other,' replied Goethe, 'I "am not speaking of those people at all, but of the dispute "between Cuvier and St. Hilaire, which has just broken out "in the Academy.'"*

When the controversy subsided, it was admitted by nearly all that St. Hilaire had received a crushing defeat. To all minds the subject had

(*) Condensed from SORET in "*Haeckel's Schopfungsgeschichte.*"

for the moment lost interest, and Frenchmen in particular had received an impression, which has since been confirmed into a national prejudice, to the effect that fixity of species is a demonstrated fact. The unwilling reception of Darwin's work in France is directly due to this enduring recollection of the controversy of 1830.

English men of science had been similarly affected by the discussion which sprang out of the publication in 1844 of the "*Vestiges of Creation.*" The anonymous author contended that "the several series of animated beings . . are . . . the results, *first*, of an impulse which has been imparted to the forms of life, advancing them . . . through definite grades of organisation . . . ; *second*, of another impulse connected with the vital forces, tending . . . to modify organic structures in accordance with external circumstances." In support of these propositions he displayed much ingenuity, and in everything except the tolerably well-kept secret of his name, considerable boldness. He tore up more than one plausible argument, and influenced not a few minds to keep open questions which those in authority were inclined to close for ever. Yet the many mistakes in matters of fact, and the weakness of some of the principal conclusions, temporarily discredited the doctrine of indefinite mutability of species. The English scientific world (for the discussion never got much

beyond England) accepted in the end, with considerable unanimity, the cautious conclusions of Sir C. Lyell, which were afterwards to be withdrawn, when the "*Origin of Species*" had thrown a fuller light upon the question. Lyell's summing-up* is as follows:—

1. That there is a capacity in all species to accommodate themselves to a certain extent to a change of external circumstances.

2 [4]. The entire variation from the original type . . . may usually be effected in a brief period of time, after which no further deviation can be obtained.

3 [5]. The intermixing [of] distinct species is guarded against by the sterility of the mule offspring.

4 [6]. It appears that species have a real existence in nature, and that each was endowed at the time of its creation with the attributes and organisation by which it is now distinguished.

We all remember how Mr. Disraeli pronounced against Darwin in the famous words, "I am on the side of the angels." Doctrines of development were not altogether new to him. He had put forth an amusing satire upon the "*Vestiges of Creation*" in "*Tancred*," and in 1846 this satire was much read:—

"After making herself very agreeable, Lady Constance

(*) "*Principles of Geology.*" Ed. 1853.

"took up a book which was at hand, and said: 'Do you "know this?' And Tancred, opening a volume which he had "never seen, and then turning to its title-page, found it was "'*The Revelations of Chaos*,' a startling work just pub- "lished, and of which a rumour had reached him.

"'No,' he replied, 'I have not seen it.'

"'I will lend it you, if you like; it is one of those books "one must read. It explains everything, and is written in a "very agreeable style.'

"'It explains everything!' said Tancred; 'it must, "indeed, be a very remarkable book!'

"'I think it will just suit you,' said Lady Constance. "'Do you know, I thought so several times, while I was "reading it'

"'To judge from the title, the subject is rather obscure,' "said Tancred.

"'No longer so,' said Lady Constance. 'It is treated "scientifically; everything is explained by geology and "astronomy, and in that way. It shows you exactly how a "star is formed; nothing can be so pretty! A cluster of "vapour—the cream of the milky way—a sort of celestial "cheese churned into light—you must read it; 'tis charming.'

"'Nobody ever saw a star formed,' said Tancred.

"'Perhaps not. You must read the "Revelations;" it is "all explained. But what is most interesting is the way in "which man has been developed. You know, all is develop- "ment. The principle is perpetually going on. First there "was nothing, then there was something; then—I forget the "next—I think there were shells, then fishes; then we came— "let me see, did we come next? Never mind that; we came "at last. And the next change there will be something very "superior to us—something with wings. Ah! that's it: we "were fishes, and I believe we shall be crows. But you "must read it.'

"'I do not believe I ever was a fish,' said Tancred.

"'Oh, but it is all proved: you must not argue on my rapid "sketch; read the book. It is impossible to contradict any-

"thing in it. You understand, it is all science; it is not like "those books in which one says one thing and another the "contrary, and both may be wrong. Everything is proved—by "geology, you know. You see exactly how everything is "made; how many worlds there have been; how long they "lasted; what went before, what comes next. We are a link "in the chain, as inferior animals were that preceded us; we "in turn shall be inferior; all that will remain of us will be "some relics in a new red sandstone. This is development. "We had fins—we may have wings."

I have little doubt that the recollection of the old "*Vestiges*" discussion, and of the practical unanimity with which the best judges had in the end pronounced against premature and ill-supported views, led Mr. Disraeli and many another Englishman to take up a confident position against what they supposed to be a revival of the same theory. Disraeli, I imagine, thought that he was merely giving rhetorical point to a decision which the scientific world would certainly uphold.

When the "*Origin of Species*" actually appeared it was read with the deepest interest. A second edition was called for in six weeks, and during the winter of 1859–60 Darwin's new book, together with the French commercial treaty, and the Volunteers, formed a chief topic of conversation. The reading public was slow to form an opinion, and looked round for direction to persons presumed to be competent judges. Of these, Lyell was perhaps the one who enjoyed the greatest share of confidence. It was not easy for him to face the position

with complete candour. The fundamental doctrine of the "*Principles of Geology*" was the continuity of the earth's history. Causes still acting had acted in time past, and had produced immense results, not so much by their intensity at any one time as by their operation through periods of unimaginable duration. It would have seemed a natural step to extend this principle to the organic world, and to show that the conspicuous differences between living species had arisen by slow increments. But Lyell did not take this step. The direct evidence was not convincing to his mind. It was enough for him to maintain, as he had always done, with great knowledge and ability, that extinction and the coming-in of new species were not sudden and out of course, but gradual and incessant. During the "*Vestiges*" controversy he had, as we have seen, given his influential voice against the indefinite modifiability of species. But the case as stated by Darwin removed the cautious scruples even of Lyell's mind. He gradually admitted that the evidence bore out the conclusions, and publicly recanted his own propositions, which had been widely circulated and generally adopted. The medium of this recantation was his new book on the Antiquity of Man, and the shock with which his opinions on that exciting topic were received was intensified by the concluding section of five chapters, in which he stated and defended Darwin's doctrines.

Lyell took this bold course merely because he felt sure that it was the right one. His native caution and his character for philosophical sobriety urged him strongly to reticence, and his letters show how painfully he felt that he was risking a great deal for the truth. He ventured his own name and reputation without reserve, but he wished to enlighten the public mind gently, and was often in alarm when younger men, who had less at stake, sharpened their epigrams and dared the opinions of the influential classes. Few men have given higher proof of their devotion to scientific truth.

The Reviews were not slow to utter their verdict. The *Edinburgh* and the *Quarterly* were strongly of opinion that Darwin had for ever wrecked his scientific standing by this publication; and on glancing over their long-forgotten pages we meet at every turn such phrases as these:—"Wantonness of conjecture"; "Extravagant liberty of speculation"; "Exuberance of fancy"; "Flighty anticipations"; "Flimsy speculations." The *Quarterly Review* closed its criticism with the following passage:—"Under such influences a man goes back to the marvelling stare of childhood at the centaurs and hippogriffs of fancy; or, if he is of a philosophic turn, he comes, like Oken, to write a scheme of creation under 'a sort of inspiration,' but it is the frenzied inspiration of

mephitic gas. The whole world of nature is laid for such a man under a fantastic law of glamour, and he becomes capable of believing anything; to him it is just as probable that Dr. Livingstone will find the next tribe of negroes with their heads growing under their arms as fixed on the summit of the cervical vertebræ, and he is able, with a continually growing neglect of all the facts around him, with equal confidence and equal delusion, to look back to any past and to look on to any future." *

It is not necessary to inquire further into the spirit which stimulated such remarks as these, nor are we obliged to rake up all the foolish things said during an exciting time, when men did their best to crush opinions which were hateful to them. But while we are not bound to dwell upon the ill-temper, the blind prejudice, or the timidity of many who strove to lead the public mind on this question, we *are* bound to name with respect those who took the unpopular side, and fought for it till the tide of favour turned. In England the leader of the Darwinian party was Professor Huxley. In him, if I may venture to refer so pointedly to a man yet living, were combined many high qualities—a courage which never faltered, an industry

(*) The *Quarterly Review* made amends nine years later by printing an article on "Geological Time and the Origin of Species," by Mr. Wallace, in which Natural Selection had fair-play.

and penetration which have left a permanent mark upon Biological science, and, more than all, a vigorous and animating personal influence which laid hold of other men and drew them in to work. Huxley was from the first convinced of the truth of Darwin's discoveries, and he told his convictions in clear, forcible language, to which every one listened. Darwin's was the deep, brooding mind which saw the truth and established it. Huxley was the instructor and advocate who forced the lesson upon the attention of all men. To have gained the support of an investigator of such eminent merit, was a strong proof that the "*Origin of Species*" was no idle speculation. That the "*Origin of Species*" was driven home to men's minds by an interpreter of such power, probably cut short by some years the interval of hesitation which necessarily preceded the period of full recognition.

Sir Joseph Hooker was another close friend of Darwin's who gave his hearty adhesion to the new doctrines. No botanist could speak with contempt of a theory which had the unqualified support of the greatest living English botanist. The Introductory Essay to the Tasmanian Flora is probably the most masterly contribution to the history of Variation of Species written by any man except Darwin himself.

If I may still further trespass against all rule

by speaking candidly of living authors, I should like to say a few words of Herbert Spencer, who is placed, in the public opinion of to-day, almost side by side with Darwin as a founder of the new philosophy. Herbert Spencer has led a retired life—the life of a student—signalised only by his successive publications and their effect on the public mind. Long known only to a very few, his influence has gradually widened, until at length he has gained as large a share of attention as is possible for a thinker so severe. In 1852 Spencer published in the *Leader* a short Essay on "The Development Hypothesis," in which he pronounced for the gradual development of organic beings, and declared against the doctrine of independent creations. The general line of argument was that adopted in the main by St. Hilaire thirty years before, while the conclusion reached had been reached by Kant, Lamarck, and Goethe still earlier. Natural Selection, the suggestion which was to fertilise the old discussions, was not anticipated by Spencer. In later years Spencer has also treated elaborately of the Principles of Biology, and has developed a system of Psychology and Sociology based upon the gradual acquirement by the human race of habits, instincts, and moral sentiments. His characteristic merits are comprehensiveness and clear logical statement. He does not overlook the consequences of any leading

position which he adopts; he arranges his evidence methodically and fully; his system is at once wide and well-connected; he has, in short, the qualities of a great thinker. The only power or passion in his writings is purely intellectual; he never travels far from topics accessible to close thinking; he has none of the animation of a discoverer, none of that play of fancy which brightens many a page of Huxley, nothing of the unstudied eloquence which here and there breaks out in the "*Origin of Species.*" Moreover, Spencer, whatever his other merits, and they are both real and considerable, cannot be quoted as a close observer of Nature. He has, indeed, entered into minute details on some biological points, but his practice in general is to carry off his facts to some inner chamber, where he may meditate upon them without distraction, and at very great length. He does not by choice, or habitually, live in that close contact with Nature which was to Darwin the indispensable condition of all activity. It is, accordingly, at times disappointing to find in Herbert Spencer, instead of the penetration of the naturalist, only the accuracy of the logician; and to this quality of mind we may attribute the circumstance that his writings have led to no special investigations—have originated no lines of inquiry. His pages are diffuse and wordy; it is true that every word is minutely considered, exquisitely chosen and

placed; but the proportion of words to things is unduly high. When we come upon his definition of Life as "the definite combination of heterogeneous changes, both simultaneous and successive, in correspondence with external co-existences and sequences," we doubt whether we gain thereby any real accession of knowledge—whether the definition embodies our loose conceptions any better than Aristotle's simpler statement that "Life is the function of the organism." So, too, with the famous definition of Evolution as "the integration of matter and concomitant dissolution of motion, during which the matter passes from an indefinite, incoherent homogeneity, to a definite, coherent heterogeneity, and during which the retained motion undergoes a parallel transformation.* "This may be all true," says one critic, "but it seems rather the blank form for a universe than anything corresponding to the actual world about us." † We are inevitably driven to contrast the '*Summa Biologiæ*' of Herbert Spencer with those fifteen special treatises of Darwin, each the best book on its subject, and each the starting-point of a whole school of investigators.

We need not minimise the honour of having defended the gradual development theory before

(*) "*Synthetic Philosophy*." Vol. I., p. 396. (Given differently in earlier editions of "*First Principles*.")

(†) Quoted in *Nature*, Nov. 25, 1880.

the "*Origin of Species*" appeared. Spencer may rank among the thirty-four names quoted in the Historical Introduction to the "*Origin of Species*," and with Kant, Meckel, Treviranus, Hunter, Camper, and others not there named, as one of those who more or less distinctly perceived what we now hold to be the truth before the day of demonstration had arrived. Nor is it of small importance to Spencer's future fame that he should have been during many years the friend of Darwin. If it were safe thus early to hazard such a speculation, I should be tempted to prophesy that it will be as an exponent of Darwinism and a valued friend of Darwin, that Herbert Spencer will be best remembered hereafter.

It would be unjust to pass over Alfred Wallace, whom Darwin always names as an independent discoverer of the Origin of Species by Natural Selection. His subsequent writings, especially those on the Geographical Distribution of Animals, have abundantly proved his ability to work out the theory which he had discovered; and his loyal recognition of the still greater merits of Darwin does not diminish his honest fame. It is to the credit of the English character that there should have been no squabbling over such a nugget as the Theory of Natural Selection.

In Germany there was little of the prejudice against transmutation theories which existed in

France and England. The "*Origin of Species*" soon created a Darwinian sect among the Germans which is subject to no reproach on the score of reticence. I cannot but think that Haeckel, the head of the party, while he has done much to strengthen, has done something to weaken the credit of the views which he adopts. It was not necessary to deride every philosophy which recognises other factors than the chemical and physical properties of the carbon-compounds, or to denounce its absurdity with the vehemence of a 16th-century Latinist. Moreover, the phylogenies of Haeckel —genealogical tables in which the pedigree of each animal type is definitely traced, with dates and proofs—are far too positive for our present knowledge. Haeckel's great powers as a working zoologist, and his effectiveness as a popular writer, would have been yet more serviceable to scientific truth, had they been blended with that faculty of assigning its just value to every fragment of the evidence, which makes Darwin's decisions so weighty.

The storm of criticism lasted for ten years, and then sullenly abated. Of its vehemence we can all form some notion, for we lived through it, and can remember the temper of the journals, reviews, and speeches. How did it affect Darwin himself? You could hardly gather from any published line of his that he had been the subject of angry

comment. If the bitterest assailant pointed out a significant fact, the fact, with due acknowledgment, appeared in the next edition of the "*Origin of Species*." If there were no new facts, the attack passed without notice. It cannot be said that any objection or comment of very great consequence was contributed by any of the controversialists. Darwin's candour, and his immense knowledge of the subject, made him the most formidable critic of his own views, and there is, I believe, no material difficulty which is not clearly stated in the "*Origin of Species*." Angry rhetoric, misunderstandings, perversions, he left as the children of time to their natural fate. No doubt he felt the reproaches which were laid so heavily upon him. It is no light thing to be reprobated by half the writers and speakers in England. No doubt he had at times his misgivings; for he was neither vain nor self-confident. "When I think," he said, in a private letter, "of the many cases of men who have studied one subject for years, and have persuaded themselves of the truth of the foolishest things, I feel sometimes a little frightened whether I may not be one of these monomaniacs." *

Meanwhile he worked hard at the preparation of the promised proofs. The "*Origin of Species*" had been a summary; it was necessary to issue

(*) Letter to Dr. Carpenter. Quoted in "*Modern Review*," vol. iv., p. 500 (1882).

the full text. This task Darwin expected to occupy the remainder of his life, which frequent illness seemed likely to cut short. His constitution, however, resisted longer than he had expected, and his fertility in thought and experiment tempted him into fields of biological inquiry only distantly, or not at all, connected with the variation of species. From 1860 to 1881 the special memoirs poured forth. They fall into two classes:— (1) Those which support or illustrate the theory of Natural Selection, viz., "*Domestic Animals and Cultivated Plants*," "*The Descent of Man*" (which includes the doctrine of Sexual Selection), and "*The Expression of the Emotions in Man and the Lower Animals.*" (2) Special and independent Natural History treatises, chiefly relating to the relation of Insects to Flowers, but including also "*Climbing Plants*" and "*The Formation of Vegetable Mould through the action of Worms.*" The "*Domestic Animals and Cultivated Plants*" was to have been one of a series, formally substantiating the assertions of the "*Origin of Species*," but the second work (on Variation in Nature), and the third (on Geological Succession, Geographical Distribution, Development, &c.), were never published. Ill-health, and perhaps the greater interest of new experimental work, interfered with tasks of such gigantic extent. Every book hit its mark; every one was accepted by the specialists to whom

it was addressed as a new and valuable gift. The rapidity with which this long series of important original researches on difficult subjects was put forth, showed the fertility of the great naturalist, and the thoroughness of his long preparation. More than all replies and arguments, this gradual exhibition of varied proofs forced even the backward to admit that Darwinism was at least not "flimsy," not "superficial," not "conjectural," not what one eminent critic chose to call it—"the most illogical book ever written."

The title of my lecture indicates an impossible task. Who can point out in one evening the significance of Darwin's life and work? To enumerate, without description or explanation, the researches of a man of science, would in any other case prove a dreary task, yet what a wealth of suggestion attaches to the barest catalogue of Darwin's observations and experiments! Coral Islands, the Means of Dispersal of Species, the Fauna and Flora of Oceanic Islands, Complemental Males, the Variation of Domestic Animals and Cultivated Plants, the Cell-making Instinct of the Bee, the Fertilisation of Flowers by Insects, Insectivorous Plants, Polymorphic Plants, Climbing Plants, Cross-Fertilisation, the Formation of Mould by Earthworms, Sexual Selection, Physiognomy, the Origin of Emotions—each of these fifteen distinct researches is a subject for a memoir of

the highest class, and in each Darwin has distanced all other inquirers. Leave out the "*Origin of Species*" altogether, and Darwin's work is still the greatest, both in extent and importance, of this age.

From 1859 down to the present day, Darwin's teaching has slowly and gradually prevailed. That check, to which all doctrines are liable in which there is a large element of error, has never come; we have never found a new generation of naturalists and physiologists turning away from Darwin's researches as from something idle or unsound. The best-informed, most progressive, and most candid minds are the readiest to accept his doctrines. A school of Embryologists, deeply persuaded of the truth of Evolution, has re-written the development of animals. None has ever spoken with heartier respect and veneration of Charles Darwin, than the young yet eminent student whom Cambridge and England lost last July—Francis Maitland Balfour. In Zoology, Fritz Müller, Haeckel, Claus, Weismann, and Dohrn have worked on Darwinian lines, and have thereby won important results. Hooker, our great master of descriptive Botany, and Sachs, the chief authority on Vegetable Physiology, are ardent disciples of Darwin. Hermann Müller, Kerner, and Sir John Lubbock have worked out more fully the relations of plants to insects, and have thereby proved

the fertility of a field which Darwin pointed out to them. All the most important discoveries in Palæontology, since 1859, are confirmatory of the derivation of species from pre-existing types. Gaudry has turned up the singular missing links from the Miocene of Pikermi; Marsh has found Pterodactyls without teeth, and birds with teeth, besides new stages in the ancestry of the horse. Huxley has elucidated the Reptilian characters of Struthious Birds, and the ornithic characters of Dinosaurian reptiles, while he has brought to light the progressive modification of the Crocodiles *pari passu* with geological time. Waldemar Kowalewsky has illustrated the divergence of the Ungulates from a common ancestor, by tracing the history of the Hyopotamidæ. Filhol has filled up gaps in the Carnivorous series by his discoveries of extinct animals at Quercy. The gulf supposed to divide Vertebrates from Invertebrates has been bridged by A. Kowalewsky's work on the Ascidians and Amphioxus, while that supposed to exist between Flowering Plants and Cryptogams has been abolished by Hofmeister's proof of the fundamental identity of the reproductive processes in the Club-mosses and the Conifers. Recent works on Ethnology, Geology, and Geological Distribution are full of Darwin; and his views have penetrated into Sociology—witness the writings of Herbert Spencer, and Bagehot's "*Darwinism in Politics.*"

Perhaps no other author can be named who has in his own lifetime created a special class of scientific literature. At least no literature gathered round the writings of any other recent author can compare in extent and importance with that vast and growing product of "Darwinismus," which already fills whole presses and whole catalogues.

It is hard to give any notion of the extent to which Darwinism occupies the thoughts of the working naturalist. He judges of the profitableness of his subject by its relation to the theory of Evolution; he sums up his results in this light. Evolution is never far off while he is framing those hypotheses and questions which, though rarely enunciated in print, are the scaffolding of his structures. It is remarkable how pregnant are the hints which come from Darwin's writings—how they lead to the very heart of the subject, and prompt the most vitally interesting inquiries. Among other striking services which Darwin has rendered to the biological world is to be reckoned this—that he has recalled men's thoughts from dry morphological abstractions to the study of adaptation. In old days men found in every animal, and in every part of it, the harmony of structure with function; each organ, each duct and cell, had its definite office, and if ever the anatomist failed to read the indications of purpose, it was because his eyes were dim, not because the purpose was

obscure or unimportant. It was by men endowed with this conviction that the fundamental truths of physiology were discovered; and Bacon's well-known epigram about the sterility of Final Causes is, like others of his often-quoted passages, simply empty. Why Natural Theology went out of fashion, I am forbidden by the ordinary rules of scientific discussion, as well as by the laws of this Society, to consider; but it is fair to remark that during the subsequent period, when men were in search, not of purpose and evidence of design, but of morphological laws, Comparative Anatomy became a very dry and lifeless thing. Cuvier had sought for the marks of adaptation of the animal to its surroundings; his method, ideally perfected, would have rendered it possible to infer from a tooth or a digit something as to the food, climate, soil, enemies, and allies of the species. After Cuvier, came the search for homologies, the detailed history of developmental changes, the minute characterisation of species. It was useful, as we shall see, but dreadfully unstimulating work. The great, though in part unattainable, object of the elders had been pronounced chimerical, and it had been decided that the student's chief task was to collect facts—facts whose bearing upon any general proposition of great interest to mankind, it was no longer attempted to trace. Into studies which must have lost their hold upon mankind,

had they been always prosecuted in this way, Darwin breathed a new life. Teleology, but without its theological inferences, came to the front once more. To Cuvier the real significance of a bone in the skull was that it protected the brain, or gave attachment to a muscle in the way best suited to that brain and that muscle. To the morphologist the bone was an element in the cranio-facial axis or its appendages. To Darwin, or to the morphologist educated by Darwin, the bone suggested two things—(1) it must be related to the animal's daily life, or it could not be there at all; (2) it must have been possessed, and probably in a different condition, by earlier and less specialised ancestors. In all places and circumstances, throughout all geological time, the duration of a species was conditioned by its adaptation to its sphere, not by its correspondence to an abstract type, and it was for the naturalist to look for the causes, sometimes obvious, sometimes buried deep below the surface, of the success or failure of every experiment of Nature.

If the test of a scientific method be the power of prediction, Cuvier could have vindicated his method. He determined the marsupial character of a new fossil animal which had not been completely extricated from its limestone matrix; and then, in the presence of his friends and of the chief sceptics, chiselled away the stone

until the characteristic marsupial bones were revealed. The morphologists never predicted anything at all, and looked upon Cuvier's triumph as something rather low. They were satisfied with pointing out that he could not have done the same thing in every case. Darwin's power of reasoning from the seen to the unseen might be illustrated by nearly every chapter of his writings, but I give only a single instance. When he was studying the Dionæa (Venus' fly-trap), he noticed that the trap, if irritated, at first closes imperfectly, leaving small spaces between the crossed spines, but after a time, if there is prey within, it shuts down close. Musing upon this, he wrote at length to an American correspondent, and asked him to visit the Dionæa in its native habitat, and ascertain whether the trap did not allow small insects to escape, retaining only those which were large enough to make the long process of digestion profitable. For reply, fourteen leaves containing naturally captured insects were sent to Darwin. Ten of these had caught large insects, three had caught ants, and one a small fly. On an average the ten larger insects were nearly half as long as the leaves by which they were enclosed, and this striking result completely confirmed the inference.

No man was ever less dejected by abuse or less elated by praise, than Charles Darwin. There is no note of triumph in his later works. He kept

on steadily at his old pursuits, finding in Natural History, in family ties, and in conversation with scientific friends his only pleasures. Those who saw much of him were filled with admiration and affection. Simplicity, courage, candour, truthfulness, modesty, industry — these everyday virtues formed the basis of a character in which there was nothing aspiring and nothing mean. He was delighted to learn from any one; he found out, not with envy, but with generous satisfaction, that others had anticipated his own thoughts, and a new research in Biology was always welcome, however remote from his immediate work. He was always ready to give patient attention to any worker who was beset by difficulties. A stranger, without introduction, might count upon Mr. Darwin's help, if only he had a definite and useful errand. In his talk there was no assumption of superiority, but just that quiet endeavour to penetrate into the heart of the subject, which appears in his writings. It was not hard for him to own a mistake. Once, in conversation with a young friend, he brought from his own experience in South America a conclusive answer to an argument which had been raised upon the origin of the æsthetic emotions. Hours after, when the young men were talking in the smoking-room, and the elders were supposed to be asleep, the door opened, and the philosopher in his dressing-gown, with slippers hastily thrust upon his

bare feet, appeared for a moment. "I have just remembered that I was wrong in my recollection of South America. It was not on the summit of the Andes, but in a Brazilian forest, that I was most impressed by the emotion of the sublime." Those who saw Darwin at home and with his family (I am sorry that I have no such recollections of my own), find stories like this most characteristic. They never quote his good sayings, though he was full of pleasantry, and they never tell of smart repartees. "Animated and fond of humour," says one of these friends, "his wit was of a singularly fascinating kind, not only because it was always brilliant and amusing, but still more because it was always hearty and good-natured."*

The venerable botanist, Alphonse de Candolle, gives a slight, though, I think, an interesting account of a day with Charles Darwin †. "It was on a beautiful autumn morning, in 1880," he says, "that I arrived at the Orpington station, where my illustrious friend had a break waiting for me. The drive to Down takes an hour; it presents nothing remarkable, unless it be the residence, surrounded by beautiful trees, of Sir John Lubbock.

(*) Mr. Romanes, in "*Memorial Notices.*"

(†) This translation is much condensed. The original may be seen in "*Darwin, considéré au point de vue des causes de son succès et de l'importance de ses travaux.*" (Geneve, 1882).

I will not here speak of the kind reception that was given me at Down, nor of the pleasure which I felt in chatting familiarly with Mr. and Mrs. Darwin and their son Francis. I will only remark that Darwin at seventy was more animated and seemed happier than when I had seen him forty-one years before. His eye was bright, and his expression cheerful, his conversation varied, free, and pleasing, his English easy for a foreigner to understand. Around the house there were no signs of his researches. Darwin used simple means. I looked for the greenhouse, in which those beautiful researches on vegetable hybrids had been made; it contained nothing but a vine. One thing struck me, although it was nothing uncommon in England, where animals are petted. A heifer and a colt were feeding close to us, with a familiarity which told of kind masters, and I heard the joyful barking of dogs. 'Here,' said I, 'the history of the variations of animals has been written; and, no doubt, the observations are still carried on, for Darwin is never idle.' I did not expect that the earthworms—those meanest of animals—over whose habitations I was walking, were to be the subject of a new memoir, in which Darwin was to show once more what great effects may spring from small causes often repeated. He had been busy with them for thirty years, had I known it. On our return to the house, Darwin showed me his

study—a large room, lighted on both sides, with one table for writing and another for experimental apparatus. An experiment on the movements of stems and roots was then in progress. I should have liked to see the registers of experiments, but the hours slipped away like minutes. The recollections of this visit I treasure with those of Jussieu, Brongniart, Geoffroy St. Hilaire, Cuvier, Arago, Robert Brown, Martius, Sir William Hooker, and other illustrious savants with whom I have conversed during my long career."

Charles Darwin died on the 19th of April, 1882, after a short illness, and on the 26th was buried in Westminster Abbey, not far from Newton. Two of his sons are already well known to science. Francis Darwin assisted his father in some of his later biological experiments, and has also published independent researches, such as that on the digestive power of the leaf-cups of the teasel. George Darwin, the new Plumian Professor at Cambridge, has treated with remarkable ability several rather diverse subjects; among others, he is understood to have been brilliantly successful in his investigation of an old problem in cosmical evolution, but there are few who have enough mathematics to read the memoir, and I am not of the number.

Such are a few of the leading incidents in the life of a man who has left behind him no one of equal power or eminence. The life has its broad and unmistakable features—immense labours, wisely planned and steadily executed; success, hardly won, but at last unstinted and ungrudged; the quiet domestic happiness of a man absorbed in great undertakings, yet always kindly and sympathetic. In that higher region of fame to which Darwin's work has already raised him, there is no record of a truer, or simpler, or nobler nature than his.

RICHARD JACKSON, 16 & 17, COMMERCIAL STREET LEEDS